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Mitigation Techniques & Missions
Impact Effects that Inform Warning, Mitigation & Costs
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PLANETARY DEFENSE: A METEORITE PERSPECTIVE

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ABSTRACT

Meteorites and meteorite falls have the potential to inform studies of the impact hazard and impact mitigation. (1) Hundreds of meteorite falls have been described in the literature. While eyewitness observations are subjective, at their core there is unique information on which to build and test numerical models of an asteroid's behavior as it passes through the atmosphere. (2) For about 25 recovered meteorites light curves have been obtained which provide quantitative information on meteorite fall and fragmentation. (3) Also in about 25 cases, fragments of the meteorite have been recovered from the 250 known meteorite craters on Earth so impact physics can be related to the properties of the projectile. (4) Studies of the meteorites provide information on their pretamospheric size, internal structure, and physical properties (tensile strength, density, porosity, thermal conductivity etc.) which are essential for numerical modelling of the atmospheric behavior of objects coming through the atmosphere. (5) The flow patterns on the fusion crust of the meteorite, and the shape of the recovered meteorite, provides information on orientation and physical behavior during flight. Petrographic changes under the fusion crust provide information on thermal history during the latter stages of flight. (6) The structure and composition of

the so-called “gas-rich regolith breccias” provide information on the outermost layer of the parent asteroid from which the meteorites came. This information is critical to certain mitigation strategies.

Most meteorite falls are relatively small events, although Chelyabinsk is a recent example of a meteorite fall energetic enough to damage property over a wide area and send over 1200 people to hospital. Crater-forming events are orders of magnitude more energetic and it is significant that all but one of the ten craters with meteorite fragments on Earth were formed by iron meteorites; clearly mechanical strength of the projectile is an important factor in determining atmospheric behavior. However, it is not clear whether a stony meteorite that produced an airburst and a strong pressure wave as it came through the atmosphere (e.g. Tunguska and Chelyabinsk) is more harmful than an iron of comparable size that makes a crater.

In summary, meteorites and meteorite falls provide direct observational evidence for the physics of an asteroid impacting the atmosphere and they provide input data and experimental tests for numerical and theoretical modeling for impact and impact mitigation. Plans for our studies include characterization of the same meteorite samples at both ARC and LLNL.

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